



# Sounding Rocket Working Group

SRPO Summary  
January 23, 2008  
Philip Eberspecker





## Presentation Outline

- Mission Results Summary (since last meeting)
- FY08-FY10 Manifest
- Mishap/Anomaly Investigation Status
- ITAR
- Education/Training Flight Opportunities
- Technology Development
- Rocket Motor Status
- Findings from January SRWG Meeting



# Mission Results Since Last SRWG



- 9 Science
  - Robertson (41.069 & 41.070)
    - Both flights successful
  - McCandliss (LIDOS 36.220)
    - 1<sup>st</sup> operational flight of new celestial ACS
    - Successful
  - Earle (36.218)
    - Successful
  - Rabin (36.241)
    - Successful
  - Kletzing (40.018 & 40.022)
    - First time two large vehicles in flight at same time
    - Both flights successful
  - McCandliss (LIDOS2 36.243)
    - 2<sup>nd</sup> operational flight of new Celestial ACS
    - Successful
  - Kintner (SCIFER-2 40.021)
    - Successful
    - 1473 km apogee



New 50K launcher installed in Norway



LIDOS on the rail

January 23, 2008

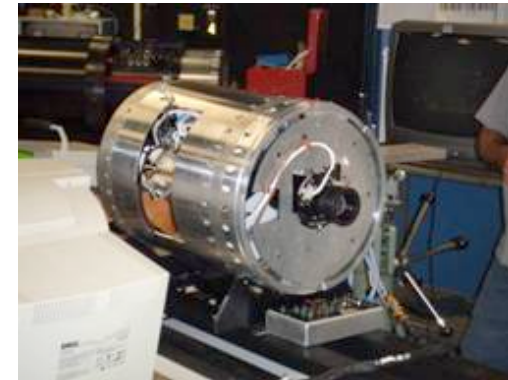
Sounding Rocket Program Office SRWG Briefing



# Mission Results Since Last SRWG



- 0 Educational
- 1 Technology
  - Celestial ACS Development
- 4 Reimbursable
  - Inflatable aeroshell for LaRC
  - 3 Targets (pure marketing task)







# FY08 Manifest



FY 2008			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
#	Vehicle Type	Experimenter												
<b>WALLOPS ISLAND</b>														
1	Terrier Brant	Earl/STORMS/Univ. Texas, Dallas	▲											
2	MLRS	Smith/Mesquito/NASA					△	}						
3	MLRS	Smith/Mesquito/NASA					△							
4	Terrier Orion	Smith/SubTech/NASA					△							
<b>WSMR</b>														
5	Black Brant IX	Rabin/EUNIS/GSFC		▲										
6	Black Brant IX	McCammon/Univ. of Wisconsin				△								
7	Black Brant IX	McCandliss/LIDOS/JHU				▲								
8	Black Brant IX	Moses/HERSCHEL/NRL							△					
9	Black Brant IX	Chakrabarti/PICTURE/Boston Univ						△						
10	Black Brant IX	Woods/University of Colorado							△					
11	Black Brant IX	Bock/Cal Tech								△				
12	Black Brant IX	Davis/MSFC									△			
13	Black Brant IX	Hassler/SWRI									△			
14	Black Brant IX	Harris/University of Washington										△		
15	Black Brant IX	Korendyke/NRL												△
<b>NORWAY</b>														
16	Black Brant XII	Kletzing/TRICE/University of Iowa			▲	}								
17	Black Brant XII	Kletzing/TRICE/University of Iowa			▲									
18	Black Brant XII	Kintner/SCIFER-2/Cornell University				▲								

# Manifest



- FY09
  - 9 assigned missions (Blue Book)
  - 7 candidate missions
- FY10
  - 3 candidate missions
  - ROSES selections not yet made





# Active Mishap Investigation Boards (MIB)



Failure	AIB lead	Status
IRVE ACS Failure – 41.XXX	NASA - GSFC	Draft report under review

## Anomaly Assessments

Issue	Assessment lead	Status
Parachute	NSROC	Latest anomaly occurred on 36.220 (LIDOS 1). Assessment completed for 36.243 (LIDOS 2) mission



## BBXII Dispersion

- Changes since Poker campaign
  - Nihka motor joint characteristics are being measured
  - Manacle ring joints are being torqued in the vertical position on the rail as part of the final pre-flight preparation
- Kletzing vehicles flew within 2 sigma
- Next Steps
  - Continue new processes
  - Monitor vehicle performance
  - Next Nihka motor purchase
    - Improved joints
    - Tighter joint tolerance







## Parachute Anomalies

- Early disreefing has occurred on approx 8 of the last 56 flights ( $\sim 14\%$ )
  - Parachute damage has occurred
  - Catastrophic payload loss on two of the early anomalies
  - No payload damage attributed to later anomalies
- Possible Causes
  - Payload reentry dynamics
  - Sharp edges on reefing line cutters
- Corrective Action
  - Inspection of suspect chutes
  - Reefing line cutters are examined to sharp edges and are being de-burred as required
  - Post flight data is being carefully reviewed to identify any trends

# ITAR



- NSROC has caught up on the short fuse TAA's
  - These were near term missions that required expedited approval
  - Some missions required technology control plans since TAA could not be put in place in time
  - Some activities required staffing substitutions
  - No mission schedules were impacted
- TAA are agreements between the NSROC contractor companies and the various foreign nationals that are exposed NSROC's defense services
  - Science team members are required to provide timely input to NRSOC so the TAA can be obtained though the Department of State
- Science teams may or may not be required to get export licenses depending on what their foreign team members are exposed to at the university
  - If they are exposed to NSROC design data at the campus, the university may need to get an export license
  - This determination is the responsibility of the university



# Education/Training Flight Opportunities

- Colorado Space Grant Rocket Flight Workshop
  - NASA Space Grant Office providing funding to defray vehicle cost
  - Wallops launch of Orion vehicle
  - June launch
- USERS (University Student Experiment Ride Share)
  - Concept
    - Four universities per flight
    - Wallops launch of Terrier-Orion vehicle
    - Competitively selected university to serve as experiment integrator
    - Competitively selected experiments
  - Pilot project under development
    - Two schools identified
    - November launch





# Technology Development

(Phil Eberspecker)



January 23, 2008

Sounding Rocket Program Office SRWG Briefing

12





# Technology Focus Areas

- Priority A – Technologies to enable core science missions
  - Funding: SR Program
  - Labor Resource: NSROC (+AETD)
  - Elements
    - Increase flight rate
      - Small vehicles
    - Maintaining existing capabilities more efficiently
      - Surplus vehicle options
      - Testing techniques
      - Operations
    - Enabling new science missions (only in outyears)
      - Increased data rate
      - Tailored trajectories
      - Next Generation Attitude Control
      - Large Vehicles



# Technology Focus Areas

- Priority B – Technologies to enable Exploration activities
  - Funding: Exploration
  - Labor Resource: AETD (+ NSROC)
  - Elements
    - TBD

Potential Spin-off to NSRP:  
- NASA relevance...



# Technology Focus Areas

- Priority C – Technologies to support new external customers
  - Funding Source: External Customers
  - Labor Resource: NSROC (+AETD)
  - Candidate Customers
    - Hypersonics community
    - Target community
  - Elements
    - High Speed Recovery
    - Data Storage
    - Larger Vehicles

Potential Spin-off to NSRP:  
- Increased payload capacity



# Technology Focus Areas

- Priority D – Technologies to enable small low-cost satellites
  - Funding: Unknown (external sources?)
  - Labor Resource: AETD (+NSROC)
  - Potential Efforts
    - Gasless ACS
    - Radiation hardening
    - Data Storage
    - Sat Com

Potential Spin-off to NSRP:  
- Next step for low-cost missions







## Active Technology Efforts

- Mesquito (MLRS-Dart)
  - Dart and interstage hardware bend test completed
  - Two “dumb” rounds scheduled for mid February launch
- Next Generation Flight Termination
- Improved Malemute Applications
- BBXI and BBXII Taurus 2<sup>nd</sup> stage replacement
- Ring Laser Gyro (SPARCS upgrade)
  - Piggy-back flight demo on Woods (36.240) mission
  - Operational on Korendyke (36.239) mission
- Power In a Box



# Motor Status

(Phil Eberspecker)



January 23, 2008

Sounding Rocket Program Office SRWG Briefing

18



# Black Brant Inventory



- Standard Black Brant
  - Floating assignments (dependent on slips)
- Black Brant Mk1
  - Motors on-hand for missions through April 2008
  - For remainder of FY08 we anticipate individual motors to be delivered about 4 months prior to flight
  - Current order exhausted by September 2009
    - 7 motors purchased by other customers may be available as emergency buffer
  - Assessing steel inventory to assess quantity of next order
    - Casing hardware exists to build 11 more units
    - Building more motors will require shift to new tubular steel
    - Order must be placed by June 2008
      - This order will likely be exhausted by mid FY10
  - Any future orders will require new tubular steel

# Nihka Motors



- Situation Critical
  - All currently manifested BBX and BBXII missions have assigned motors
  - 2 (maybe 3) are still available for assignment
  - Will likely run out in early FY10
- Plan
  - Purchase 5-10 units
    - Quantity tied to next Brant purchase
    - Dependent on steel availability
  - NRE is required





## Other Motors



- Talos
  - 25 at WFF
  - 24 additional tagged for NSRP
- Terrier MK70
  - 63 at WFF
  - 150 tagged for NSRP
- Improved Orion
  - 104 at WFF
- Patriots
  - 10 at WFF
- MLRS
  - 56 at WFF (50 recently delivered)





# Findings from June 2007 SRWG



January 23, 2008

Sounding Rocket Program Office SRWG Briefing

22



# I. NSROC Corporate Memory

*The SRWG requests insight into how mission experiences are documented and made available for future missions.*

- Mission Technical Closeout reports are generated for each mission
- All mission documentation is stored in a central repository
- Mandatory reading of all failure and anomaly reports by engineering and MM staff
- Weekly technical staff meetings
- Technical Peer Reviews
- Engineering mentors
- Adept database for all drawings, schematics, procedures, and most tech documents
- MSS systems contain all mission milestone documents and other tech documents
- SQA Switchboard documents and tracks all NCR's, CATS, CR's, and Safety related items
- Inventory control process tracks all components of all NSROC built systems
- Cognizant engineer and alternate defined for most major systems
- Assignment of all engineers into peer review panel roles for experience and involvement



## II. Poker Flat

*The SRWG requests clarification on new cloud cover rules, radio interference the the new NSF AMISR science radar and maintenance of down range ground-based science facilities*

- Cloud Cover Launch Limitations
  - SRPO concurs with the SRWG's finding on this subject.....we cannot limit our launch opportunities
  - Topic was discussed at length during annual PFRR meeting at WFF (fall 2007)
    - WFF Safety Office position is that FAA has no jurisdiction to impose such regulations
    - PFRR position is that they must comply with locally mandated FAA restrictions
      - This restriction was “negotiated” with local FAA authorities over the past several years
  - Actions from annual meeting were assigned to begin resolution of this discrepancy
    - Agreements to be provided to SRPO & Safety
    - Safety & SRPO review FAA authority/responsibility
    - Follow up actions will be taken as appropriate



## II. Poker Flat

*The SRWG requests clarification on new cloud cover rules, radio interference the the new NSF AMISR science radar and maintenance of down range ground-based science facilities*

- AMISR Radar Interference
  - AMISR construction recently completed
    - Final panels added to array this summer
    - Interference characteristics may have changed???
  - SRPO, NENS, NSROC, & NASA Engineering recently met twice on this subject
    - Plan is being put in place to investigate source of interference and possible solutions
      - Additional testing with TM at Poker
      - RF survey trip by NASA engineering
  - Craig Heinselman has been contacted on this a couple of times by SRPO and NSROC
    - We will need AMISR cooperation to resolve this issue



## II. Poker Flat

- AMISR Continued.....
- 5<sup>th</sup> harmonic of AMISR transmit frequency is 2246.5 MHz.....we cannot filter this frequency!!!
  - Frequency observed during last year campaign
  - Noise floor raised 10-15 dB....loss of sensitivity
- Serious problem for our missions
  - Potential payload interference (systems) on ascent
  - Limits multiple TM link on payloads
  - Limits wide band TM links
  - Sensitivity reduction reduces link on high performance missions
- Potential solutions.....
  - Avoid using 2246.5 MHz region – not practical
  - Filter AMISR – already being done....can we do more??
  - Filters in TM Systems – not likely a product of our systems
  - Move AMISR – Best technical solution if all else fails
    - \$\$, political, and schedule issues abound!!!
  - Use other tracking resources
    - Relocate WFF Mobile – technical, logistical, and \$\$
    - NOAA – possibility being investigated
  - Turn AMISR Off during our missions – Last resort
- We are not overly optimistic.....don't expect a miracle!!!





## II. Poker Flat

*The SRWG requests clarification on new cloud cover rules, radio interference the the new NSF AMISR science radar and maintenance of down range ground-based science facilities*

- SRPO needs a better understanding of what downrange science instruments exists, what is required, and who is responsible for upkeep and maintenance
  - SRWG can help here
  - The contract does not clearly spell out what instruments/location we are required to maintain.....it only list examples.
  - Facilities we are required to maintain list only Ft. Yukon and Kaktovic
  - The suite of instruments and supporting infrastructure seems to keep growing??
- Maintenance of science instruments is not historically a responsibility of the program
  - We provide roughly ½ man-year “optics engineer” support
  - Some contractual obligations undertaken to provide/maintain facilities provide basic infrastructure
  - Again, SRPO needs to better under our obligations so we can do what is best for program and within scope of our programmatic mandate
- Recommend we set up a working group to provide direction on this effort



### III. Improved Attitude Systems

*Address the timing uncertainty in gyro-based attitude data and the remaining uncertainties regarding the plan to upgrade, manufacture and test the ST-5000.*

- GLNMAC Timing
  - A time sync pulse has been incorporated
  - The solution was demonstrated on 4 flights (2x Robertson, Earle, and 1x Kletzing)
  - New roll position computation error due to timing should be less than 0.1 deg.
- ST-5000
  - Five units will be sufficient to cover the manifest
  - Design underway for smaller, lighter more robust ST-5000 Next





## IV. Innovative Pyro replacements

*The SRWG suggests that NSROC consider the use of shaped memory alloy pin pullers and other innovative devices to replace pyros for mechanical deployment functions...*

- Shape Memory Alloy (SMA) devices have many practice applications for use on Sounding Rockets
  - Some benefits are cleanliness (low out gassing), re-usable (support extensive testing), low shock, reduced safety concerns
  - Devices are used in space applications and have good reliability
  - Disadvantages include low power for mechanism activation, large size/weight, cost, slow activation
    - Cost range \$3K-\$4K (low quantity) with 12 week delivery time
- SMAs have some limited Sounding Rocket flight history
  - SMA pin pullers used on the Lynch, Larson, and Lessard missions





## IV. Innovative Pyro Replacements (cont.)

- AETD/engineering is conducting trade study of existing non pyrotechnic devises
  - Devises from several (6?) manufacturers are under review
  - Devises include pin pullers, separation nuts, Frangibolts, thermal knives, paraffin devises, ejector release mechanisms
  - Trades include size/weight, power, activation, timing
- NSROC is investigating practical applications
  - Potential applications include door deployment, boom deployment, sensor cap deployment
  - Applications under consideration are S-19 canard de-couple and MLRS nosecone separation
  - Several devises are electrically compatible with standard CDI and pyrotechnic power systems
  - Could augment ground testing with reusability characteristics
  - Seeking acquisition to begin bench testing and performance evaluation